American Journal of Public Health
*and* THE NATION'S HEALTH Vol. XI No. 3

Volume XIX March, 1929 Number 3

# Age Distribution in Milk-Borne Outbreaks of Scarlet Fever and Diphtheria*

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THAT there has been an unusual proportion of adult cases in milk-borne outbreaks of scarlet fever, seems first to have been noted by Littlejohn in 1899.[1] Ker,[2] in his textbook, gives it not only as a characteristic of scarlet fever but of diphtheria as well. More recently, Clarke[3, 4, 5] has called attention to the phenomenon and suggested its value as a means for the early diagnosis of milk-borne outbreaks.

Strangely enough, although this peculiarity has been noted in the reports of numerous outbreaks, the only allusions to it as a characteristic appear to be those quoted, all of which are from Edinburgh authorities. Ker,[2] indeed, thought this might be merely a local characteristic due primarily to the extensive use of milk on porridge by Scotch adults. Of the 9 diphtheria outbreaks cited by Clarke,[5] however, 5 were in England.

The only allusions to this peculiarity as a characteristic of milk-borne infection that I have found in American literature are in the pamphlet on scarlet fever published by the U. S. Public Health Service in 1914,[6] in an article of my own on outbreaks attributed to pasteurized milk,[7] and in the recent study by Armstrong and Parran.[8] There has not been, so far as I am aware, any inquiry to determine how frequently this peculiarity shows itself nor to account for its occurrence.

With the idea of contributing something toward the answer to the

* Read at a Special Session on Epidemiology of the American Public Health Association at the Fifty-seventh Annual Meeting at Chicago, Ill., October 18, 1928.

first of these questions, I have tabulated by age all of the cases attributed to milk-borne infection with scarlet fever and diphtheria that have occurred in New York State since 1914, and all of those found in recent literature in which the age distribution has been given. Further, through the courtesy of S. J. Crumbine, M.D., I have received the names of places in the United States that have been reported to him as having had milk-borne outbreaks of scarlet fever and diphtheria since 1923. By following these up I have been able, either through the state directors of communicable diseases or the local health officers, to obtain the age distribution in 11 outbreaks of scarlet fever and 2 of diphtheria.* Altogether a series of 21 outbreaks of scarlet fever comprising 1,362 cases, and 11 outbreaks of diphtheria comprising 709 cases have been collected. These outbreaks are listed in Tables II and III. No outbreak in which exposure was limited to a special age group has been included.

A higher incidence in children is generally accepted as a charac-

TABLE I

PERCENTAGE OF CASES BY AGE IN MILK-BORNE INFECTIONS AS COMPARED WITH INFECTIONS FROM ALL SOURCES

| | Column 1 Typhoid | | | Column 2 Scarlet Fever | | | Column 3 Diphtheria | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | | B | A | | B | A | | B |
| Ages | Milk-borne * | | All cases † | Milk-borne * | | All cases † | Milk-borne * | | All cases † |
| Years | No. | Per cent | Per cent | No. | Per cent | Per cent | No. | Per cent | Per cent |
| Total | 919 | | | 1,105 | | | 241 | | |
| 0–4 | 66 | 7.2 | 4.5 | 206 | 18.6 | 17.4 | 24 | 10.0 | 22.2 |
| 5–9 | 147 | 16.0 | 13.8 | 269 | 24.3 | 38.0 | 39 | 16.2 | 34.8 |
| 10–14 | 131 | 14.2 | 14.3 | 174 | 15.7 | 23.1 | 32 | 13.3 | 17.8 |
| 15–19 | 131 | 14.2 | 14.2 | 119 | 10.7 | 8.4 | 26 | 10.8 | 7.0 |
| 20–29 | 168 | 18.2 | 21.7 | 195 | 17.6 | 7.9 | 49 | 20.3 | 8.7 |
| 30–39 | 118 | 12.9 | 14.0 | 80 | 7.2 | 3.8 | 30 | 12.4 | 5.6 |
| 40–49 | 77 | 8.4 | 9.3 | 37 | 3.3 | 1.0 | 22 | 9.1 | 2.5 |
| 50–59 | 43 | 4.7 | 5.3 | 17 | 1.7 | 0.3 | 11 | 4.6 | 1.0 |
| 60 and over | 38 | 4.2 | 2.9 | 8 | 0.7 | 0.1 | 8 | 3.3 | 0.4 |
| 10 and over | | 76.8 | 81.8 | | — | — | | — | — |
| 15 and over | | — | — | | 41.4 | 21.5 | | 60.5 | 25.2 |
| | | | | Age Ratios | | | | | |
| −10 : 10+ | | 1 : 3.31 | 1 : 4.47 | | — | — | | — | — |
| −15 : 15+ | | — | — | | 1 : 0.70 | 1 : 0.27 | | 1 : 1.35 | 1 : 0.34 |

* In New York State 1917–1926

† New York State places of less than 200,000, 1915–1924, Vol. 1, *Annual Report* New York State Dept. of Health for 1925.

teristic of milk-borne typhoid fever outbreaks. In order to test the general truth of this observation and to ascertain its constancy, I have examined our New York data comprising 64 typhoid outbreaks, with 919 cases of known ages, attributed to milk-borne infection. These have been tabulated by age by individual outbreaks and then assembled for the entire series and the percentages by age periods calculated. The latter are presented in Table I, Column 1A. For comparison, the percentages by the same age groups for all typhoid cases in places of less than 200,000 in New York State are given in Column 1B. It is seen that 7.2 per cent of the milk-borne cases are under 5 years of age as compared with 4.5 per cent for all cases, an excess of 60 per cent. The excess is 27 per cent in the age group 0–10 years and 45 per cent at ages 60 years and over. Our figures therefore tend to confirm the observation that children are unusually liable to attack in milk-borne typhoid, but indicate that this liability is largely due to the excess at ages under 5. They further indicate that people over 60 years of age are relatively more subject to attack from milk-borne typhoid than younger people over 5 years of age.

Columns 2A and 2B show corresponding percentages for scarlet fever. Here we see that there is a slightly higher percentage of milk-borne cases at ages under 5 but markedly lower percentages at ages 5–9 and 10–14. The excess at age 0–4 is about 8 per cent, but the deficiency at 5–14 is 35 per cent. At all ages over 14 there is a consistently higher percentage of cases in milk-borne scarlet fever than in scarlet fever from all causes. It will be noted too that the relative excess grows greater with each succeeding decade as age increases.

Column 3 shows the corresponding percentages for diphtheria. We note that there is not an excess of milk-borne diphtheria at ages 0–4 but a deficiency of over 50 per cent. At ages 5–14 the deficiency is 25 per cent while in every age group above 14 there is an excess which increases relatively just as in scarlet fever.

Although, for reasons which will be explained later, the figures of certain outbreaks have not been used in calculating these percentages for scarlet fever and diphtheria, the omissions do not change the result much. It seems to be true then that a high age incidence is a general characteristic of milk-borne scarlet fever and diphtheria and not merely a peculiarity dependent primarily on an unusual age distribution in the consumers. Not only this, but it is much more marked than the incidence among children in milk-borne typhoid fever.

The next question is to determine how constantly this characteristic appears in individual outbreaks. Table II lists each of the outbreaks of scarlet fever for which satisfactory age data have been se-

TABLE II

AGE RATIOS IN MILK-BORNE OUTBREAKS

SCARLET FEVER

| | Total Cases | Ratios −15 : 15+ | Per cent of cases over 15 years |
|---|---|---|---|
| N. Y. All cases 1915–24 * | 66,951 | 1 : 0.27 | 21.5 |
| N. Y. Rural cases only † | 24,031 | 1 : 0.32 | 24.4 |
| Wappingers Falls, N. Y., and vic. 1915 | 53 | 1 : 0.66 | 39.6 |
| Ossining, N. Y. 1921 | 24 | 1 : 0.33 | 25.0 |
| Croton, N. Y. 1922 | 68 | 1 : 1.62 | 61.8 |
| Huntington, N. Y. 1922 | 90 | 1 : 0.76 | 43.3 |
| Buffalo, N. Y. 1923 | 59 | 1 : 0.26 | 20.3 |
| Cohoes, N. Y. 1924 | 20 | 1 : 0.67 | 40.0 |
| Binghamton, N. Y. 1925 | 39 | 1 : 0.77 | 43.6 |
| Troy, N. Y. 1926 | 14 | 1 : 1.00 | 50.0 |
| Deposit, N. Y. 1926 | 34 | 1 : 1.13 | 50.0 |
| Bristol, Conn. 1924 | 125 | 1 : 0.67 | 40.0 |
| Flint, Mich. 1924 ‡ | 100 | 1 : 1.04 | 51.0 |
| Pittsfield, Mass. 1924 | 7 | 1 : 0.00 | 0.0 |
| Clinton, Mass. 1925 | 56 | 1 : 0.81 | 44.6 |
| Netcong and Stanley, N. J. 1925 | 50 | 1 : 0.82 | 34.0 |
| Scio, O. 1925 | 50 | 1 : 0.47 | 32.0 |
| (?), Minnesota 1926 | 67 | 1 : 0.43 | 29.9 |
| St. Johns, Mich. 1926 | 73 | 1 : 0.43 | 30.1 |
| Kalispell, Mont. 1927 ** | 150 | 1 : 0.70 | 41.3 |
| Washington, N. J. 1927 | 199 | 1 : 1.06 | 51.8 |
| Janesville, Wis. 1928 | 21 | 1 : 1.63 | 61.9 |
| LaCrosse, Wis. 1928 | 63 | 1 : 0.50 | 33.3 |
| Total milk-borne cases | 1,362 | | |
| Average | | 1 : 0.75 | 39.2 |
| Median | | 1 : 0.70 | 40.0 |

* Places of less than 200,000 population
† Cases occurring in unincorporated territory
‡ Ice cream
** Ages over 30 years not distributed

cured. Three of these have not been used in calculating the percentages in Column 2A. The outbreak in Flint, Mich.,[10] was not used because the infection was transmitted through ice cream and therefore probably exposed a greater percentage of older people than milk ordinarily would. The Pittsfield, Mass., outbreak was excluded because there seemed to be a question as to the sufficiency of the evidence incriminating milk. While I do not pretend to have gone into the evidence in each of these out-of-state outbreaks, it has been fur-

nished and examined in several instances and in the others I have assumed that it was adequate because of the sources through which the age data came. The age distribution in this Pittsfield outbreak was so far out of line that it was queried and the response was not satisfactory. It was felt that in an outbreak of this size the exclusion of other possibilities should be made with considerable care before acceptance.

The only reason for excluding the Kalispell, Mont., outbreak was the grouping of all cases 30 years of age and over. The evidence was ample but the figures could not be used in calculating the percentages for the decades beyond 30, and their exclusion made very little difference in the percentages under 30.

Column 2 of Table II shows the ratio of the number of scarlet fever cases under 15 years of age to the number 15 years and over. For comparison, this ratio is given for all scarlet fever, regardless of mode of infection, as it occurred in places of less than 200,000 in New York State. Also, since the age incidence tends to rise as congestion decreases, this ratio is given for the unincorporated places only in New York State. Running down this column we find, aside from the Pittsfield outbreak, one (Buffalo) in which the ratio is less than that for all places less than 200,000. This ratio is probably a little higher than for the general run of cases in a city the size of Buffalo, but it certainly is not enough higher to be significant or to be useful as an indicator. In this outbreak the evidence incriminating the milk supply was quite conclusive. All of the cases were on one milk route; they occurred explosively; there was sufficient dispersion to make school or neighborhood contact improbable; and 6 unrecognized cases had existed for nearly two months on a dairy farm supplying milk to this dealer.

There are 5 other outbreaks in this list in which the ratio is less than twice that for rural New York. If we take this ratio as a criterion, this characteristic is present in significant proportions in 70 per cent of milk-borne outbreaks of scarlet fever. Applying this criterion to the 15 outbreaks of typhoid occurring in New York State since 1916, involving 19 cases or more each, there was a significant percentage of cases under 5 years of age in only 40 per cent of them. Under 10 years of age there were only 2 out of the 15 that had twice the percentage usually found in typhoid from whatever cause.

Table III is a table for diphtheria corresponding to Table II for scarlet fever. The figures of two outbreaks in this list were not used in calculating the percentages in Table I—the one in Rhode Island[11] because it was an ice cream outbreak and because the age distribution

beyond the 15th year was not given, and the Westchester County outbreak because it was transmitted by certified milk and hence largely limited to small children. The latter affords the *only* instance in which the ratio of cases over 15 was less than in the general run of cases either in New York State or in its rural districts only. The only other outbreak in which the ratio fell below twice that of rural New York occurred in Suffern, and here it will be noted that it approaches this criterion very closely.

It cannot be definitely determined whether a high ratio of adult cases of scarlet fever or diphtheria necessarily means milk-borne infection; probably it does not, even if outbreaks occurring among groups of adults in camps and institutions be excepted. A recent non-explosive outbreak of diphtheria in rural New York was confined almost exclusively to adults and was apparently spread by contact alone. Such an occurrence, however, would require somewhat exceptional conditions, and in this connection it should be remembered

TABLE III

AGE RATIOS IN MILK-BORNE OUTBREAKS

DIPHTHERIA

| | Total Cases | Ratios −15 : 15+ | Per cent of cases over 15 years |
|---|---|---|---|
| N. Y. All cases 1915–24* | 50,254 | 1 : 0.34 | 25.2 |
| N. Y. Rural cases only† | 13,446 | 1 : 0.45 | 30.9 |
| Lincoln, Neb. 1913 | 110 | 1 : 1.39 | 58.2 |
| Suffern, N. Y. 1915 | 13 | 1 : 0.86 | 46.1 |
| Middletown, N. Y. 1916 | 18 | 1 : 1.57 | 61.6 |
| Rhode Island and vic. 1916‡ | 402 | 1 : 1.58 | 61.2 |
| Westchester Co., N. Y. 1920** | 66 | 1 : 0.27 | 21.2 |
| Saranac Lake, N. Y. 1922 | 16 | 1 : 3.00 | 75.0 |
| Painesville, O. 1924 | 23 | 1 : 0.92 | 47.8 |
| Stoneham, Mass. 1925 | 24 | 1 : 3.80 | 79.2 |
| Olean, N. Y. 1925 | 14 | 1 : 1.33 | 57.1 |
| Alexandria Bay, N. Y. 1926 | 12 | 1 : 1.40 | 58.3 |
| Mexico, N. Y. 1926 | 11 | 1 : 2.67 | 72.7 |
| Total milk-borne cases | 709 | | |
| Average | | 1 : 1.71 | |
| Median | | 1 : 1.40 | 58.3 |

* Places of less than 200,000 population
† Cases occurring in unincorporated territory
‡ Ice cream
** Certified milk

TABLE IV

DATA ON DEPOSIT, N. Y., OUTBREAK OF SCARLET FEVER

| Ages Years | Total Persons on Route: Pop. on Route | Attacked | Attack Rate Per cent | Milk Drinkers Only: Pop. | Attacked | Attack Rate Per cent |
|---|---|---|---|---|---|---|
| Total | 255 | 34 | 13 | 129 | 32 | 25 |
| 0–4 | 24 | 3 | 12.5 | 12 | 2 | 17 |
| 5–9 | 22 | 9 | 41 | 21 | 9 | 43 |
| 10–14 | 22 | 4 | 18 | 12 | 4 | 33 |
| 15–19 | 22 | 5 | 23 | 12 | 4 | 33 |
| 20 and over | 165 | 13 | 8 | 72 | 13 | 18 |
| 0–15 | 68 | 16 | 24 | 45 | 15 | 33 |
| 15 and over | 187 | 18 | 10 | 84 | 17 | 20 |

that a high percentage of young children is not an infallible indication of milk-borne typhoid. It is sometimes found in water-borne typhoid if the community has had either a high endemic rate or has been subject to outbreaks at short intervals. In an outbreak in Watervliet, N. Y., in 1917, out of 120 cases of known age, 28 per cent were in children under 10.

I have not attempted an explanation of the phenomenon, partly because of limited space, but principally because of the limited data on which to base or by which to test any theory that might be evolved. The most obvious theory, namely that the exposure of adults is increased *relatively* more than the exposure of children, does not seem to be borne out in the two small outbreaks (shown in Tables IV and V). These are the only outbreaks for which I could obtain a census by age of the dealer's customers.

TABLE V

DATA ON MEXICO, N. Y., OUTBREAK OF DIPHTHERIA

| Ages Years | Total Persons on Route: Pop. | Not immunized | Attacked | Rate—non-immunized |
|---|---|---|---|---|
| Total | 63 or 66 | 49 or 52 | 11 | 22 or 21 |
| 0–4 | 3 or 5 | 1 or 3 | 0 | 0 |
| 5–9 | 4 | 3 | 0 | 0 |
| 10–14 | 12 | 8 | 3 | 37.5 |
| 15–19 | 6 | 5 | 2 | 40 |
| 20 and over | 38 or 39 | 32 or 33 | 6 | 19 or 18 |
| 0–15 | 19 or 21 | 12 or 14 | 3 | 25 or 21 |
| 15 and over | 44 or 45 | 37 or 38 | 8 | 21 |

In the Deposit, N. Y., outbreak (Table IV), satisfactory data on the use of milk by each individual on the route were recorded.

It will be seen that the attack rate in adult milk drinkers is only about one-third less than in children. In the Mexico, N. Y., outbreak (Table V), the attack rate in adults is equal to or only slightly less than it is in children, making no allowance for the milk drinking habits at the different ages. These tables are submitted not because they prove or disprove anything, but merely to illustrate the kind of data we shall have to accumulate before the explanation can be reached.

In conclusion, I would say it will always pay to investigate the milk supply whenever an unusual *number* of adult cases of scarlet fever or diphtheria occur in a community. Suspicion should be excited by an unusual *number* of adult cases occurring within a limited period. Milk-borne outbreaks which are non-explosive do occur and a still greater number of them lack explosiveness in their beginnings. The practical application of this age characteristic therefore may lead, as it has in Edinburgh, to the early recognition of milk-borne scarlet fever and diphtheria and to correction of the cause.

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9. I am indebted to the following for their assistance in securing the data respecting outbreaks in their states or communities:
S. J. Crumbine, M.D., General Executive, American Health Assn., New York, N. Y.
Howard A. Lanpher, M.D., Epidemiologist, Dept. of Health, Hartford, Conn.
C. L. Scamman, M.D., Director, Division Communicable Diseases, State Health Dept., Boston, Mass.
Don M. Griswold, M.D., D.P.H., Deputy Commissioner of Health, Lansing, Mich.
O. McDaniel, M.D., Director, Division Preventable Diseases, Minneapolis, Minn.
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F. L. Leister, M.D., Health Officer, Marshfield, Wis.
Fred Welch, M.D., Health Officer, Janesville, Wis.
A. M. Murphy, M.D., Health Officer, LaCrosse, Wis.
E. E. Epting, M.D., Director, Anderson Co. Health Unit, Anderson, S. C.
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